

1 WHAT IS CLAIMED IS:

2

3 1. A method for obtaining seismic data comprising the steps of:

4

5 (a) translating a constellation of seismic energy sources along a
6 survey path, the seismic energy sources including a reference
7 energy source and at least one satellite energy source;

8

9 (b) activating the reference energy source and the at least one
10 satellite energy source at a time delay relative to the activation
11 of the reference energy source once each at spaced apart
12 activation locations along the survey path to generate a series of
13 superposed wavefields which propagate through a subsurface
14 and are reflected from and refracted through material
15 heterogeneities in the subsurface, the time delay being varied
16 between the spaced apart activation locations; and

17

18 (c) recording seismic data including seismic traces generated by
19 the series of superposed wavefields utilizing spaced apart
20 receivers.

21

22 2. The method of claim 1 further comprising:

23

24 processing the seismic data using the time delays to separate signals
25 generated from the respective energy sources.

26

27 3. The method of claim 2 wherein:

28

29 the step of recording seismic data includes recording amplitudes of the
30 superposed wavefields, the location of the receivers, the locations of
31 the energy sources, and the time delays between the activations of the
32 reference energy source and the at least one satellite energy source.

- 1 4. The method of claim 2 wherein:
2
3 processing the seismic data further includes sorting into a common-
4 geometry domain and replicating the seismic traces of data into
5 multiple datasets associated with each particular energy source;
6
7 time adjusting each trace in each replicated dataset in the common-
8 geometry domain using the time delays associated with each particular
9 source to make signals generated from that particular energy source
10 generally coherent while rendering signals from the other energy
11 sources generally incoherent.
12
- 13 5. The method of claim 4 wherein:
14
15 the common-geometry domain is one of common-midpoint, common-
16 offset, common-receiver and common-azimuth.
17
- 18 6. The method of claim 4 further comprising:
19
20 attenuating the incoherent signals from the datasets of coherent signal
21 and incoherent signal associated with the respective energy sources to
22 produce enhanced data sets associated with the respective energy
23 sources.
24
- 25 7. The method of claim 6 wherein:
26
27 the attenuation step includes using at least one of Radon filtering, FX
28 filtering, dynamic noise attenuation, stacking, and migration.

- 1 8. The method of claim 6 wherein:
2
3 the step of attenuation includes using dynamic noise attenuation
4 wherein the relative amplitudes of the coherent signals from each of
5 the respective energy sources are preserved.
6
- 7 9. The method of claim 1 wherein:
8
9 the at least one satellite energy source includes a plurality of energy
10 sources, and time delays are variable between each of the plurality of
11 energy sources in the constellation at each of the activation locations.
12
- 13 10. The method of claim 1 wherein:
14
15 the time delay includes a constant portion t_c which remains constant for
16 any particular source for the duration of the seismic survey and a
17 variable portion t_v , which varies for each source and for each activation
18 location.
19
- 20 11. The method of claim 10 wherein:
21
22 the constant portion t_c is different for each satellite source.
23
- 24 12. The method of claim 1 wherein:
25
26 the receivers are disposed generally in a linear alignment along a
27 predetermined length.
28
- 29 13. The method of claim 12 wherein:
30
31 an elongate streamer includes a cable and the receivers and the
32 streamer is towed by a marine vessel.

- 1 14. The method of claim 13 wherein:
2
3 the reference energy source and the at least one satellite energy
4 source is generally collinear with the streamer.
5
- 6 15. The method of claim 13 wherein:
7
8 at least one of the energy sources is located laterally outboard from the
9 linear alignment of receivers a distance of at least one-tenth of the
10 length of the receiver cable.
11
- 12 16. The method of claim 13 wherein:
13
14 the energy source located farthest upstream from the streamer is
15 located at least one half the length of streamer upstream from the
16 streamer.
17
- 18 17. The method of claim 13 wherein:
19
20 the energy source located farthest downstream from the streamer is
21 located at least one half the length of streamer downstream from the
22 streamer.
23
- 24 18. The method of claim 1 wherein:
25
26 the receivers are fixed relative to the earth.
27
- 28 19. The method of claim 1 wherein:
29
30 an elongated cable of receivers resides inside a well bore.

- 1 20. The method of claim 1 wherein:
- 2
- 3 the variable time delays range from plus to minus one-half the time
- 4 interval between successive activation locations.